PATENT SPECIFICATION 947,311

DRAWINGS ATTACHED.

Inventor:—FRANK SWAIN HAWKINS.

947,311

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International Classification :—H 01 j (C 03 b, c, F 06 l).

COMPLETE SPECIFICATION.

Improvements in or relating to Sodium-Vapour-Resistant Glass Tubing and to Electric Lamps Incorporating such Tubing.

We [illegible]

ERRATA

SPECIFICATION NO. 947,311

Page 1, line 26, *for* "attached" *read* "attacked"

Page 3, line 21, *for* "refering" *read* "referring"

Page 3, line 51, *for* "clips" *read* "clip"

Page 3, line 77, *for* "sodium" *insert* "resistant"

THE PATENT OFFICE,
25th March, 1964

D 1033/1(10)/R.109 200 3/64 PL

The electric discharge lamps referred to contain a discharge envelope, usually of U-shape, which is either contained within an outer Dewar flask or is sealed within an outer bulb, the intervening space being evacuated. In this latter case heat-conserving glass sleeves are usually applied over the whole of the U-shaped discharge envelope, or separately one on each limb of the U.

The discharge envelope itself cannot be made of ordinary commercial glasses consisting mainly of silica, since such glasses are attached under operating conditions by the hot sodium vapour and blackened in a few hours, and in many cases splinter and even disintegrate completely. Sodium-vapour-resistant glasses, hereinafter referred to simply as sodium-resistant glasses, are known, but in view of their unsatisfactory physical and chemical properties, and in particular their poor resistance to moisture, they are not normally utilised alone for the discharge envelope. Usually the envelope is constructed from a base (i.e. support) glass, which is generally an ordinary soda-[illegible]ing up the discharge envelope, and for a tube of about 1 millimetre wall thickness a sodium-resistant layer of about 0.05 millimetres has usually been found to be adequate. Preferably the thickness of the sodium-resistant layer is not made greater than is necessary, to avoid the setting up of excessive strain due to the small mismatch which may exist between the thermal expansion coefficients of the two glasses.

Various compositions of sodium-resistant glasses have been proposed. Of these, some have been found to darken in use, developing an amber or brown-coloured stain, which is objectionable in appearance and which in time becomes sufficiently dense to reduce the light output of the lamp to such an extent as to terminate its useful life. Other glasses have been proposed which do not darken in this way.

In the manufacture of a sodium vapour discharge lamp the discharge envelope is formed, evacuated and baked, the sodium is introduced and the envelope filled with an inert gas at a low pressure, this gas serving to support the discharge when the lamp

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COMPLETE SPECIFICATION.

Improvements in or relating to Sodium-Vapour-Resistant Glass Tubing and to Electric Lamps Incorporating such Tubing.

We, THE GENERAL ELECTRIC COMPANY LIMITED, of Glen House, Stag Place, Victoria, London, S.W.1, a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to composite glass tubing designed to resist the action of sodium vapour acting on its interior surface, and to electric discharge lamps containing sodium.

The electric discharge lamps referred to contain a discharge envelope, usually of U-shape, which is either contained within an outer Dewar flask or is sealed within an outer bulb, the intervening space being evacuated. In this latter case heat-conserving glass sleeves are usually applied over the whole of the U-shaped discharge envelope, or separately one on each limb of the U.

The discharge envelope itself cannot be made of ordinary commercial glasses consisting mainly of silica, since such glasses are attached under operating conditions by the hot sodium vapour and blackened in a few hours, and in many cases splinter and even disintegrate completely. Sodium-vapour-resistant glasses, hereinafter referred to simply as sodium-resistant glasses, are known, but in view of their unsatisfactory physical and chemical properties, and in particular their poor resistance to moisture, they are not normally utilised alone for the discharge envelope. Usually the envelope is constructed from a base (i.e. support) glass, which is generally an ordinary soda-lime-silica glass, with its internal surface coated with a layer of the sodium-resistant glass. The co-efficients of thermal expansion of the glasses used for such a composite tube must, of course, be closely matched, in order to avoid setting up strains which would damage the sodium-resistant layer during fabrication or in use. The thickness of the layer of sodium resistant glass, must, of course, be sufficient to avoid the base glass being exposed during the working of the glass tube necessary for making up the discharge envelope, and for a tube of about 1 millimetre wall thickness a sodium-resistant layer of about 0.05 millimetres has usually been found to be adequate. Preferably the thickness of the sodium-resistant layer is not made greater than is necessary, to avoid the setting up of excessive strain due to the small mismatch which may exist between the thermal expansion coefficients of the two glasses.

Various compositions of sodium-resistant glasses have been proposed. Of these, some have been found to darken in use, developing an amber or brown-coloured stain, which is objectionable in appearance and which in time becomes sufficiently dense to reduce the light output of the lamp to such an extent as to terminate its useful life. Other glasses have been proposed which do not darken in this way.

In the manufacture of a sodium vapour discharge lamp the discharge envelope is formed, evacuated and baked, the sodium is introduced and the envelope filled with an inert gas at a low pressure, this gas serving to support the discharge when the lamp

is started, and metallic sodium is introduced. The discharge envelope is then sealed and heated, to enable the sodium to be distributed along the whole length of the envelope. When the lamp is started, a discharge is first established in the gas, and some of the sodium is gradually volatilized and takes part in the discharge to an increasing extent as the lamp heats up.

In normal operation over prolonged periods sodium tends to condense in the coolest portions of the discharge envelope and to evaporate from the hottest portions. In those parts of the discharge which are depleted of sodium, the voltage gradient, and therefore the rate of power dissipation, are greater, and in those parts of the discharge which are enriched in sodium the voltage gradient and the power dissipation are less, so that the mal-distribution of sodium tends to become aggravated and, in the course of time parts of the discharge envelope are completely deprived of sodium. When this has occurred, these parts of the discharge envelope, instead of having the high light output in operation of the sodium vapour discharge, have only the relatively faint glow due to the rare gas filling. The useful life of the lamp may thus be terminated by the migration of the sodium.

The inert gas filling usually consists of neon with the addition of a small proportion of argon, the effect of which addition is to lower the voltage required to start the discharge. In use the argon (or other gas present at low pressure) is "cleaned up" by the discharge, and the starting voltage consequently increases, until eventually the lamp is unable to start in the circuit for which it was designed.

It has been found in practice that the useful life of the lamp is particularly liable to be limited by either sodium migration or by gas "clean-up" when the inner surface of the discharge envelope is of the sodium-resistant glass of the non-darkening kind referred to above; on the other hand if the inner surface is of the darkening sodium-resistant glass the migration of sodium does not occur on such a scale as to be so objectionable, and the gas filling is less rapidly "cleaned up", and the lamps seldom fail from these causes.

An object of the present invention is to provide an improved form of sodium resistant glass tube and another object is to provide a sodium vapour discharge lamp made from such tubing with which an improved compromise is obtainable between the rate of darkening of the discharge envelope and the average rate of failure by sodium migration or gas "clean up".

According to the present invention a composite glass tube consists of an outer layer of base glass, an intermediate layer of non-darkening sodium resistant glass, and an inner layer of darkening sodium resistant glass, the outer layer being thicker than the combined thickness of the intermediate and inner layers.

Preferably the outer layer is very substantially thicker than the combined thickness of the intermediate and inner layers, for example, ten or more times as thick.

Preferably the intermediate layer is thicker than the inner layer, for example two or three times as thick.

The invention includes within its scope sodium vapour electric discharge lamps having a discharge envelope made from glass tubing according to the above aspect of the invention, and containing sodium vapour and a filling of an inert gas at a suitable pressure for sustaining an electric discharge, the combined thickness of the inner and intermediate layers being sufficient to prevent the outer layer of base glass from being appreciably attacked by the sodium vapour in use of the lamp.

The invention will be further described by way of example, with reference to the drawing accompanying the Provisional Specification in which:—

Figure 1 shows a cross-section of a length of glass tubing according to the invention; and

Figures 2 and 3 show longitudinal sections in two planes at right angles through a sodium vapour discharge lamp incorporating such tubing.

Referring first to Figure 1, the tubing therein shown in section consists of an outer layer 1 of base glass, an intermediate layer 2 of a non-darkening sodium-resistant glass, and an inner layer 3 of a darkening sodium-resistant glass; the relative thicknesses of the three layers have been distorted in the drawing for clarity.

The chemical compositions in weight percentages of the three glasses are as follows:—

Base glass:—SiO_2 72.0, Al_2O_3 1.5, CaO 5.2, MgO 3.1, Na_2O 17.5, K_2O 0.2, B_2O_3 0.5.

Non-darkening Sodium-resistant glass:—SiO_2 0.6, B_2O_3 22.1, Al_2O_3 24.4, CaO 7.0, BaO 44.8, SrO 0.2, Na_2O 0.2, K_2O 1.4.

Darkening Sodium-resistant glass:—SiO_2 8.2, Al_2O_3 26.5, CaO 7.2, Na_2O 12.9, B_2O_3 45.2.

The expansions of glasses of these compositions are closely matched.

Tubing of this kind was manufactured by hand, a small quantity of the darkening sodium-resistant glass being gathered on a blowing iron, a second, rather larger, amount of the non-darkening sodium-resist-

ant glass being then gathered covering the first gather, and these two gathers then covered by a substantial quantity of the base glass. The whole was then worked into three ply composite tubing by the usual process of blowing and drawing by hand.

In one example of tubing manufactured in this way from glasses of the above compositions for the discharge envelopes of sodium vapour discharge lamps the outside diameter of the glass tube was 17 millimetres, and the average wall thickness was 1.0 millimetre, the intermediate layer being 0.029 millimetres thick and the inner layer being 0.013 millimetres thick.

Figures 2 and 3 show a sodium vapour discharge lamp in which the discharge envelope has been fabricated from tubing manufactured as described above with reference to Figure 1.

Refering now to these figures, the discharge envelope is of a U-shape, shown at 4 in Figure 3, and is formed by bending a length of composite tubing back on itself. A pumping stem is sealed into the U tube at the apex of the bend and electrodes 5 and 6 are sealed in at each end by means of a pinch seal. The tube is evacuated and baked, a quantity of sodium is melted in through the pumping stem, inert gas is introduced at low pressure, and the stem is then sealed off at 7. After sealing, the tube is again heated and tilted so as to distribute the molten sodium along the whole length of the envelope.

Heat-conserving sleeves 8 and 9 are passed over each of the arms of the U-shaped discharge envelope so formed, a mica spacer 10 is placed in position at the ends of the sleeves and engaging the two ends of the discharge envelope, and the electrodes are connected to conductors sealed through a glass pinch 11. A wire 12 connected to one electrode is passed spirally around both arms of the U to assist starting. The assembly is provided with a spring clip 13 engaging the seal-off pip 7 and a further clip 14 engaging the free ends of the two heat-conserving sleeves, and is inserted in an outer bulb 15 into which it is sealed, the clips 13 and mica spacer 10 serving to maintain it in position. The outer bulb is then evacuated, gettered, sealed, and provided with a cap 16 bearing contact studs connected to the electrodes 5 and 6.

WHAT WE CLAIM IS:—

1. A composite glass tube consisting of an outer layer of base glass, an intermediate layer of non-darkening sodium resistant glass, and an inner layer of darkening sodium resistant glass, the outer layer being thicker than the combined thickness of the intermediate and inner layers.

2. A composite glass tube according to Claim 1 wherein the thickness of the inner layer is less than the thickness of the intermediate layer.

3. A composite glass tube according to Claim 2 wherein the outer layer is at least ten times as thick as the combined thickness of the intermediate and inner layers and the intermediate layer is two or three times as thick as the inner layer.

4. A composite glass tube according to any preceding claim wherein the base glass, darkening sodium resistant glass and non-darkening sodium glass each has the composition as specified therefor in the example of the invention hereinbefore described with reference to Figure 1 of the drawing accompanying the Provisional Specification.

5. A sodium vapour electric discharge lamp having a discharge envelope made from glass tubing according to any preceding claim and containing sodium vapour and a filling of inert gas at a suitable pressure for sustaining an electric discharge, the combined thickness of the intermediate and inner layers being sufficient to prevent the outer layer of base glass from being appreciably attacked by the sodium vapour in use of the lamp.

6. A composite glass tube which is constructed with three layers of glass of the compositions and with the dimensions hereinbefore described with reference to Figure 1 of the drawing accompanying the Provisional Specification.

7. A sodium vapour electric discharge lamp which is constructed as shown in and as hereinbefore described with reference to Figures 2 and 3 of the drawing accompanying the Provisional Specification.

For the Applicants,
J. E. M. HOLLAND,
Chartered Patent Agent.

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947311 PROVISIONAL SPECIFICATION
1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

Fig. 1

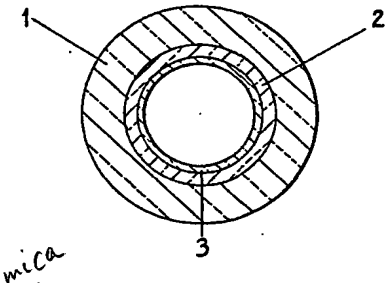

Fig. 2

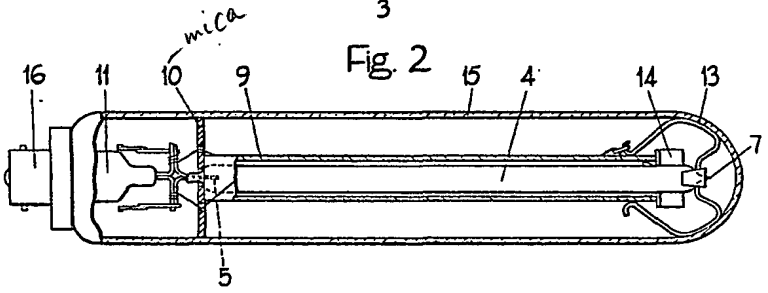

Fig. 3